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PAR 245

BPE High-Magnification Lens Sets

4 April 1966

PROJECT AUTHORIZATION REQUEST

PAR 245
4 Apr 66

SUBJECT: BPE High-Magnification Lens Sets

TASK/PROBLEM

1. Design, fabricate and test prototype optical systems to extend the Briefing Print Enlarger (prototype) PAR 243, upper limit magnification range from 60X to 140X - 160X.

PROPOSAL

2. Introduction: There is a need for magnification greater than 60X on the Briefing Print Enlarger (BPE) to provide briefing illustrations for group presentation. The required image sharpness in the print for this type of viewing is less than that required for nearby viewing.

3. General Approach:

a. We propose to design and fabricate two additional objective-lens/condenser assemblies to be interchangeable with the six assemblies developed on PAR 202/224 which are being incorporated into the prototype Briefing Print Enlarger on PAR 243.

b. The proposed high-magnification lens sets will be designed for printing upon color-blind, blue-sensitive, print stock (such as Kodabromide paper or Kodak Fine Grain Positive Film) or upon blue-green, sensitive print stock (such as Polycontrast paper).

c. Tentative values for focal length, magnification range, and field coverage for each of the proposed lenses are shown in Table 1. The values of relative aperture shown in Table 1 are design goals. Upon the basis of the performance of the black-and-white 40X to 60X lens of the present BPE set, it is assured that the high-magnification set will have a relative aperture no smaller than f/2.8. The estimate of the minimum high contrast, axial resolution is based upon the sample of that lens.

PROGRAM OBJECTIVES

4. Design, fabricate and test two lens/condenser systems suitable for installation and production use in the Briefing Print Enlarger (prototype) PAR 243, as additions to the original six lens set to extend the magnification range.

5. The expected performance is shown in Table 1.

6. The lenses will be suitable for exposing color-blind or Polycontrast type print stock.

SCHEDULE

7. A tentative schedule covering major phases of effort is shown in Figure 1. The time span indicated to complete the subject program is based on actual start of work. Upon approval to proceed and/or start of work, schedule will be reviewed and necessary changes reported as required.

Table 1

DESIGN GOALS

OBJECTIVE LENSES, HIGH MAGNIFICATION, FOR BPE

LENS	NOM. E.F.	RELATIVE APERTURE	MAGN.	O.A.C.	FIELD RADIUS NEG.	FIELD RADIUS PRINT	APPROX. FIELD ANGLE	MIN AXIAL RESOLUTION* NEG. (lines/mm)	MIN AXIAL RESOLUTION* PRINT (lines/mm)
G	0.810"	f/2.6	59.9X	50"	0.260"	15.6"	17°40'	550	9.2
			74.7X	62"	0.260"	19.4"			7.3
			97.0X	80"	0.260"	25.2"			5.7
H	0.517"	f/2.2	94.9X	50"	0.165"	15.6"	17°40'	550	5.8
			118.0X	62"	0.165"	19.4"			4.7
			153.0X	80"	0.165"	25.2"			3.6

*Prints from high-contrast USAF three-bar test targets prepared on Microscope Resolution Target Camera at the contractor's plant onto Kodak Fine Grain Print Film (or equal). Exposure through W98 (blue) filter.

TENTATIVE SCHEDULE

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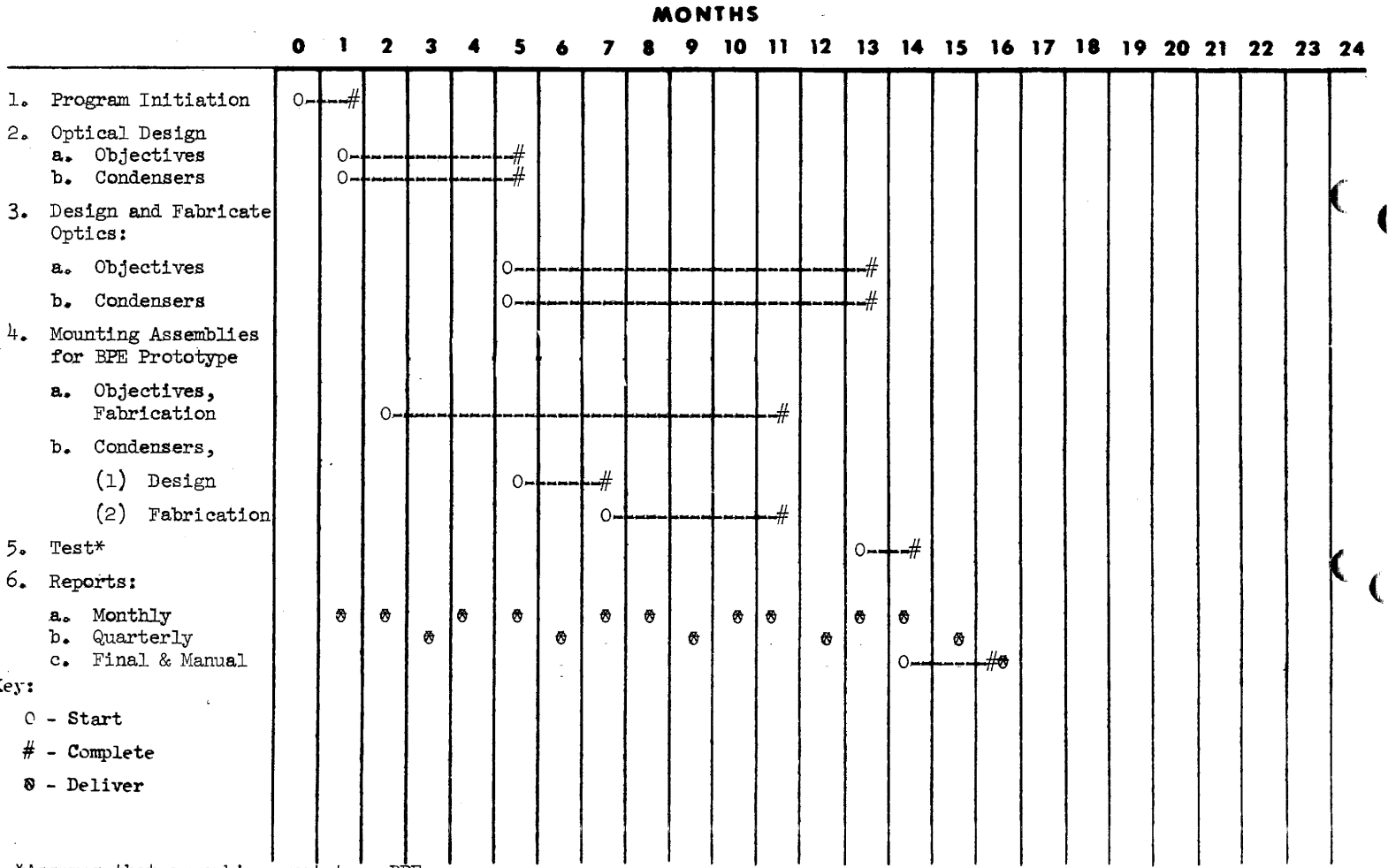
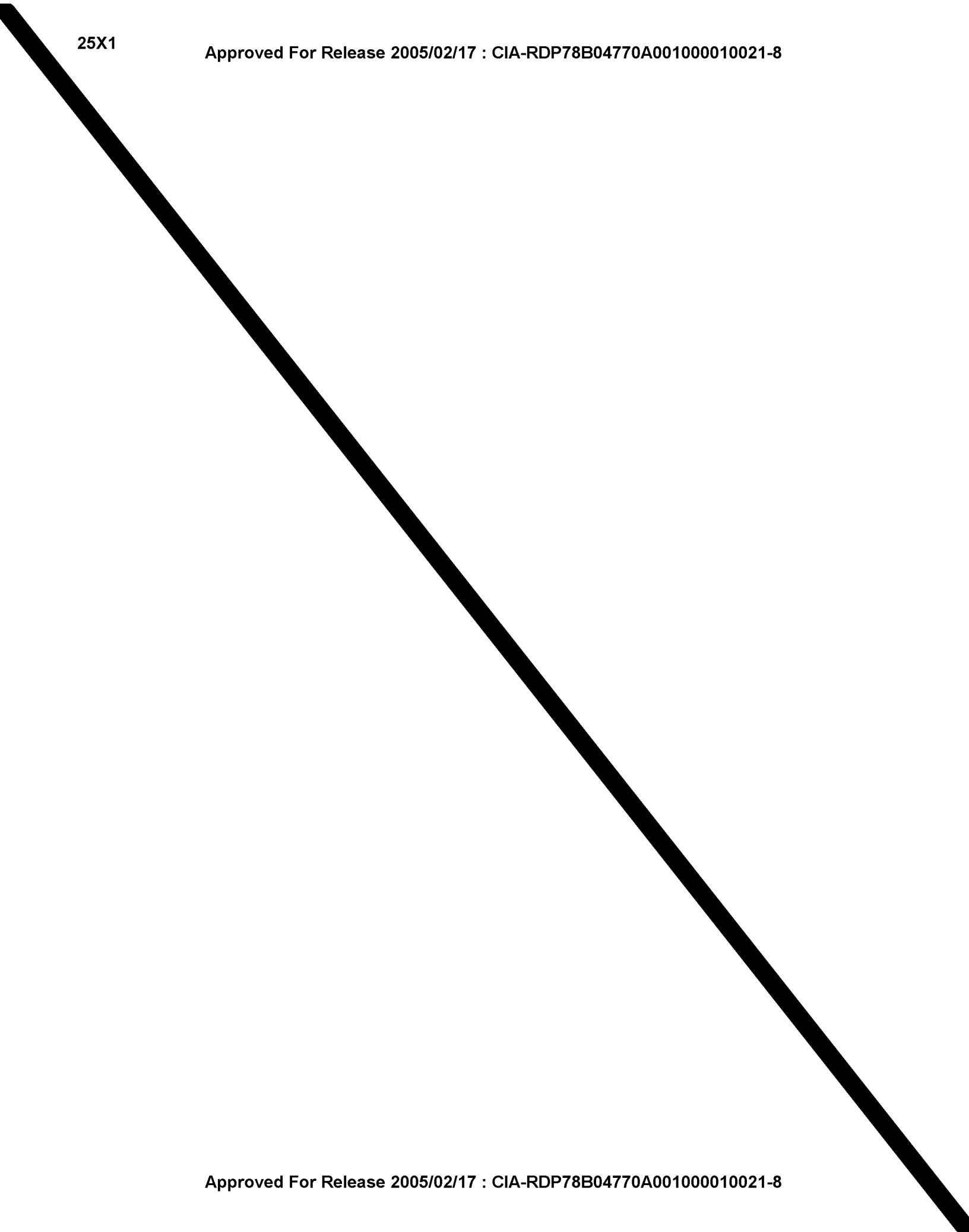


*Assumes that a working prototype BPE is available at the contractor's plant.

Figure 1



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Attachment to:

PAR 245
30 Jun 66

SPECIFICATION 469334

HIGH MAGNIFICATION LENSES FOR BPE (4600A)
(Released 8 Jun 66)

1.0 Objective and condenser lens sets to provide 60X to 150X magnification in the Briefing Print Enlarger.

2.0 This specification describes two objective and condenser lens sets to be used for enlargement of high definition black-and-white aerial photographs. These lenses extend the magnification range of the BPE upward from 60X to 150X.

3.0 UNUSUAL REQUIREMENTS

3.1 The enlarger, with the subject lenses, must provide any magnification ratio from 60X to 150X to a 20" x 24" print. The data of Table I were derived by thin lens formulae and show a tentative pair of lenses meeting requirements with a maximum semi-field angle of about 18° and with object-to-image distances of 50 to 80 inches.

3.2 The negative will be held between flat glass surfaces wet by index matching fluid. The gate element on the objective lens side should be plano-plano glass, 3.0mm thick. The gate element on the lamp side should be plano-plano glass, 6.0mm thick.

3.3 The condenser system should include 2 - 4mm thick heat absorber elements (Pittsburgh No. 2043) and allow space for insertion of a color filter at a position protected from the lamp heat by both heat absorber elements.

The distance from the negative plane to the color filter should be between 1.75 and 3.56 inches. The minimum air space for the color filter is 0.32 inch.

3.4 The condenser system should be designed to project a 12.3mm filament diagonal to fill 95% of the projector lens aperture. The envelope of the lamp will be up to 0.81 inch from the filament plane.

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3.5 The use of a methacrylate condenser element with an aspheric surface may be considered where adequate spherical correction of the condenser system would otherwise require several elements. The plastic element cannot be in contact with the negative and the immersion fluid nor next to the lamp.

4.0 FOCAL LENGTH

See Table 1.

5.0 RELATIVE APERTURE

See Table 1. The apertures specified may be reduced to f/2.8 if improved definition can be achieved. The lens aperture will be fixed in fabrication and need not be capable of later adjustment.

6.0 FIELD OF VIEW

See Table 1.

7.0 MAGNIFICATION

See Table 1.

8.0 FIELD ILLUMINANCE OR VIGNETTING

The illuminance at the maximum field radius specified in Table 1 shall not be less than 70% of that on the system axis.

9.0 TRANSMITTANCE

Not specified.

10.0 ACHROMATISM

The system will be used with narrow band blue filters. Correction 4600A with achromatization at 4200A and 5000A is suggested.

11.0 SPACE OR SIZE LIMITATIONS

See Table 1. Also, the lamp-centerline-to-negative-plane distance should not exceed about ten (10) inches. If this becomes difficult, please consult the project engineer.

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12.0 SPECIAL MATERIALS

Domestic glass is desired but if higher performance is obtainable with imported glass it should be used.

13.0 PERFORMANCE

13.1 For each of the lens design as computed at 61.5" overall conjugate and λ = 460 mμ, the design goal is to have 90% of the computed rays fall within:

a. A circle equal to the diameter of the first minimum of the diffraction pattern to 6° (or more) off axis.

b. A circle twice the diameter of the first minimum to 12° (or more) off axis, and

c. A circle 4X the diameter of the first minimum to 18° (or more) off axis.

13.2 Report

Upon completion of the designs, the project engineer requires formula sheets and energy distribution diagrams at 0°, 6°, 12°, and 18° off axis for the three overall conjugate distances indicated in Table 1 for each of the designs before sample fabrication is begun.